



UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
-----------------	-------------	----------------------	---------------------	------------------

10/700,325

11/03/2003

Jick M. Yu

006938 CPI/COPPER

5134

7590

10/05/2004

Applied Materials, Inc.
Patent/ Legal Dept., M/S 2061
P.O. Box 450A
Santa Clara, CA 95052

EXAMINER

PERT, EVAN T

ART UNIT

PAPER NUMBER

2829

DATE MAILED: 10/05/2004

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.

10/700,325

Applicant(s)

YU ET AL.

Examiner

Evan Pert

Art Unit

2829

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 03 November 2003.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-20 is/are pending in the application.
- 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 1-20 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☒ The drawing(s) filed on 03 November 2003 is/are: a) ☒ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
 2. ☐ Certified copies of the priority documents have been received in Application No. _____.
 3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- | | |
|---|---|
| 1) <input checked="" type="checkbox"/> Notice of References Cited (PTO-892) | 4) <input type="checkbox"/> Interview Summary (PTO-413) |
| 2) <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948) | Paper No(s)/Mail Date. _____ |
| 3) <input type="checkbox"/> Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) | 5) <input type="checkbox"/> Notice of Informal Patent Application (PTO-152) |
| Paper No(s)/Mail Date _____ | 6) <input type="checkbox"/> Other: _____ |

DETAILED ACTION

Claim Rejections - 35 USC § 102

1. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(a) the invention was known or used by others in this country, or patented or described in a printed publication in this or a foreign country, before the invention thereof by the applicant for a patent.

Claim Rejections - 35 USC § 103

2. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

3. Claims 5-8, 13-14 and 18-20 are rejected under 35 U.S.C. 102(a) as anticipated by Cooney, III et al. (US 6,429,524) or, in the alternative, under 35 U.S.C. 103(a) as obvious over Cooney, III et al. (US 6,429,524) in view of Skinner et al. (US 2003/0073314 A1).

As a 102 Rejection

While the '524 patent is silent on the specific phrase "no more than 1.5 nm," the '524 patent does indicate that the barrier layer "is about 0.5 to 3 nanometers thick" [e.g. col. 3, lines 16-20]. Since the '524 patent discloses a range that includes "no more than 1.5 nm," the range of "0.5 to 3 nm" can reasonably be interpreted as anticipating the range "no more than 1.5 nm."

Regarding claim 5, the '524 patent discloses a copper metallization structure, comprising: a via hole (115) extending through a dielectric layer (100) over an underlying conductive feature (necessarily a conductive feature in substrate 110); a metal nitride barrier layer (135) formed on sides of said via hole (120) including a bottom side thereof (130), wherein a thickness of said barrier layer at said bottom side of said via hole is no more than 1.5 nm (which is included and reasonably anticipated in the range of "about 0.5 to 3 nm" at col. 3, lines 15-18); and a copper layer formed over the barrier layer (145) at said bottom side (130) of said via hole (115).

Regarding claim 6, the range of "0.5 to 0.9 nm," for example, is disclosed as part of the preferred range of "0.5 to 3 nm" disclosed by the '524 patent.

Regarding claim 7, the '524 patent discloses embodiments of 1, 2 and 3 monolayers, which are thicknesses necessarily corresponding to "no more than three cycles of atomic layer deposition" [col. 3, line 20].

Regarding claim 8, the copper layer comprises a copper seed layer (145) overlaid with electroplated copper (150) [col. 3, lines 35-37 and 42-46].

Regarding claim 13, the '524 patent discloses a method of forming a via structure in a dielectric layer having a via hole formed there through overlying a conductive feature beneath said dielectric layer (i.e. a conductive feature in the substrate 110), comprising the steps of: depositing by chemical vapor deposition (see plasma CVD chamber in Fig. 3) a nitride barrier layer (i.e. TaN) in said via hole and having a thickness at a bottom of said via hole of no more than 1.5 nm; and forming a copper seed layer over said barrier layer on sides and said bottom of said via hole.

Regarding claim 14, the '524 is particularly directed to "tantalum nitride" [Title].

Regarding claims 18 and 20, the '524 patent discloses a monolayer of TaN, and also discloses "0.5 to 3 nm" thickness, which is reasonably interpreted as anticipating "less than 1.0 nm" as well as "less than or equal to 1.0 nm" recited in claims 18-19.

Regarding claim 20, the method of the '524 patent discloses that the method further comprises electroplating copper over the seed layer in the via hole [col. 3, lines 35-37].

As a 103 Rejection

In a narrow interpretation, the '524 patent is silent about "no more than 1.5 nm" and instead recites "about 0.5 to 3 nm." Applicant may want to emphasize that "no more than 1.5 nm" is tangibly different and novel over "about 0.5 to 3 nm," meaning that "about 0.5 to 3 nm" does not actually anticipate "no more than 1.5 nm," as set forth in the 102 version of the rejection above.

However, Skinner et al. discuss the trends in the industry at [0005] wherein "barrier/cladding thickness must be decreased from 13 nm to 10 nm by 2005 *and to 0 nm by 2008 in order to meet industry goals*" [emphasis added].

It would have been obvious to one of ordinary skill in the art at the time of the claimed invention to adopt a thickness "no more than 1.5 nm" based on the range of the '524 patent being "about 0.5 to 3 nm," motivated to approach "0 nm by 2008 in order to meet industry goals," as disclosed by Skinner et al..

4. Claims 9, 11-12 and 15 are rejected under 35 U.S.C. 103(a) as being unpatentable over Cooney, III et al. (US 6,429,524 B1), as applied to claim 13, and further in view of Chen et al. (US 2002/0117399 A1).

Regarding claims 9, 11-12 and 15, Cooney, III et al. is silent about "ALD" (i.e. atomic layer deposition) as a method of deposition for the barrier layer.

However, Chen et al. disclose that "very thin layers of metal oxides and nitrides can be grown by atomic layer deposition," in which monolayers are deposited, such as for forming a very thin layer of tantalum nitride as a barrier.

Since Cooney, III et al. disclose that the tantalum nitride barrier is "1 to 6 monolayers in thickness," one of ordinary skill in the art would be motivated to deposit the metal nitride layer "by no more than six cycles of ALD" in order to form "one to six monolayers" as taught by Cooney, III et al..

Regarding claim 12, the seed is by "sputtering" [col. 3, lines 30-31].

5. Claims 10 and 16-17 rejected under 35 U.S.C. 103(a) as being unpatentable over Cooney, III et al. (US 6,429,524 B1) in view of Chen et al. (US 2002/0117399 A1), as applied to claims 9 and 15 above, and further in view of Skinner et al. .

While Clooney II, et al. is silent about "no more than three cycles" [i.e. claims 10 and 16] and is silent about "no more than two cycles" [i.e. claim 17], Clooney, III et al. does teach "one to six monolayers" [col. 3, line 20].

Skinner et al. indicates that barrier layers must approach 0 nm by 2008 "in order to meet industry goals" [0005].

It would have been obvious to deposit "no more than 2" or "no more than 3" monolayers of the "one to six monolayers" disclosed by Cooney, II et al., motivated by the teaching of Skinner et al. that barrier layers must be near 0 nm by 2008, "in order to meet industry goals."

6. Claims 1-4 are rejected under 35 U.S.C. 103(a) as being unpatentable over Cooney, III et al., as applied to claims 5 and 8 above, and further in view of applicant's "prior art" Fig. 1.

Regarding claims 1-4, Cooney, III et al. are silent about the underlying conductive feature on the substrate being "an underlying copper feature" and that "a crystallography of the copper feature is aligned with a crystallography of the copper layer across the barrier layer at the bottom side of the via."

However, applicant's admission of prior art indicates that "for vias interconnecting two metallization layers, the conductive feature 12 is a copper metallization," meaning that the prior art with which Cooney, III et al. are improving upon, obviously includes "an underlying copper feature" for the case of connecting a lower copper metallization to an upper copper metallization.

It would have been obvious to one of ordinary skill in the art at the time of the claimed invention to form the underlying conductive feature in the substrate 110 of Cooney, III et al. of "copper" to be "an underlying copper feature." One of ordinary skill in the art would have been motivated to practice the invention of Clooney, II et al. with an underlying copper feature, motivated to connect a lower and upper level of copper metallization as was known in the art.

Regarding the "alignment of crystallography" between the copper above and below the barrier, such alignment is a necessary result of practicing the invention of Clooney, III et al. with an underlying copper feature. That is, applicant indicates that crystallographic orientation between copper above and below the barrier is aligned when a thin TaN nitride barrier is practiced as is done in Clooney et al. [p. 9, lines 8-21].

Regarding claim 2, the defects being aligned, like the alignment of crystallography, is a necessary result of practicing the invention of Clooney, III et al. with an underlying copper feature in substrate 110 [applicant's spec., p. 9, lines 8-21].

Conclusion

7. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Evan Pert whose telephone number is 571-272-1969. The examiner can normally be reached on M-F (7:30AM-3:30 PM).

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Michael Tokar can be reached on 571-272-1812.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

ETP
September 22, 2004


EVAN PERT
PRIMARY EXAMINER